§21. Possibility of ECRH-driven "Electron Root" in LHD[1]

Murakami, S., Nakajima, N., Okamoto, M., Gasparino, U., Maaßberg, H., Romé, M.
(Max-Planck-Institut für Plasmaphysik, Germany)
Marushchenko, N. (Institute of Plasma Physics, NSC-KhPTI, Ukraine)

A stronger positive radial electric field, E_r, ($\geq$ 40kV/m) has been measured in the central plasma region in W7-AS[2,3]. The experimental heat diffusivity becomes much lower than the neoclassical one for $E_r \simeq 0$, leading to highly peaked central electron temperatures (up to 6keV). The experimental findings strongly suggest a connection between the "electron root" feature and the ECRH driven flux due to the drift motion of ripple trapped suprathermal electrons. In previous Monte Carlo simulations we have pointed out the important role in the ambipolarity condition in the central region comparing with the neoclassical bulk plasma flux by DKES code.

In this paper the possible scenario of this "ECRH-driven electron root" is considered in the LHD plasma. In the previous studies for W7-AS[4] the "ECRH-driven electron root" could be expected when the ECRH driven flux, Γ^{ECRH}, is comparable with background neoclassical flux, Γ^{NC}. In order to obtain such a large Γ^{ECRH} we need a sufficiently big fraction of trapped suprathermal electrons. So we assume the LHD magnetic configurations with $\Delta_{ax} = 0$cm (0cm shift of magnetic axis from the coil center) and the heating point at $r/a \sim 0.2$. Also we assume 1MW of heating power and the following plasma parameters; $n_0 = 4 \times 10^{18}\mathrm{m}^{-3}$, $T_{e0} = 2.5$keV, $Z_{eff} = 2$ and $B_0 = 1.5$T.

The background neoclassical flux can be simply written, assuming $E_r \sim 0$ ("ion root") and no density gradient, as

$$\Gamma^{NC} = \delta_D \frac{q_e}{T_e}, \qquad (1)$$

where q_e and T_e are the electron heat flux and temperature, respectively, and δ_D is the ratio between D^e_{12} and D^e_{22} with D^e_{ij} the transport matrix coefficients for electrons. Then, the total background neoclassical flux is evaluated as

$$F^{NC} = \int \Gamma^{NC} dS \simeq 4 \times 10^{20}\mathrm{sec}^{-1},$$

where the value of δ_D is assumed to be $\delta_D \sim 1/6$[5].

We evaluate the ECRH-driven flux in the LHD plasma assuming these parameters. Figure 1 shows the comparison of the ECRH-driven flux (solid line) with background neoclassical flux (dashed line) in the LHD plasma. We can see that a large ECRH-driven flux is obtained in the central plasma region and that the value of ECRH-driven flux is comparable with the ion root flux near $r/a \sim 0.2$. So we can expect that the ECRH-driven "electron root" would be observed near the central region in the LHD.

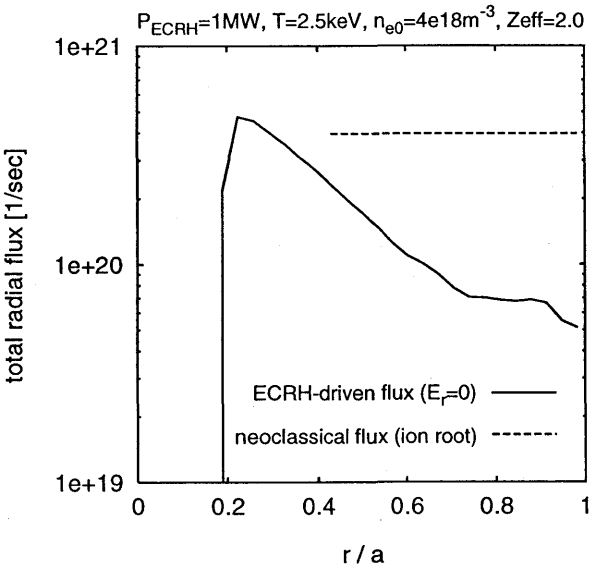

Fig. 1: *Comparisons of the simulation result of the ECRH driven flux with the total background plasma flux (Eq. (1)) in LHD.*

References

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